A Bioluminescence Bathyphotometer for an Autonomous Underwater Vehicle

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LONG-TERM GOALS

We seek to develop bioluminescence bathyphotometers (BPs) suitable for use on autonomous underwater vehicles, coastal zone moorings and for deployment from small boats operating near shore in order to provide spatial scale data important to understanding plankton population dynamics in the coastal regime.

OBJECTIVES

Building on the experience of this past year in which our new type small BPs (MDDBP) successfully operated in several configurations, we continued to refine them, looking towards establishing a standard unit suitable for general use for oceanographic studies. We also continued sea tests to fully evaluate this equipment.

APPROACH

Two field studies were conducted: December in Monterey Bay and July at the LEO-15 site. Monterey Bay emphasized investigation of capture effeciency of the small BPs while at LEO-15 a major component of the work was a field intercalibration of the small BPs with a HIDEX. The remainder of the year was devoted to laboratory calibrations and data analysis.

WORK COMPLETED

A patent disclosure was made to the University of California covering the basic bathyphotometer. This was subsequently released to the Office of Naval Research.

Two units were provided to the Naval Oceanographic Office for field-testing.

RESULTS

A major question in evaluation of any small BP is its **capture effeciency**. Bioluminescence is produced by an immense variety of organisms, some of which are quite powerful swimmers with excellent sensory endowment. Our MDDBPs are intended only to capture radiolaria, dinoflagellates, copepods, appendicularians and other small protochordates, and small ctenophores and medusae. These represent by far the dominant element of marine bioluminescent sources. Bacterial luminescence

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is widespread in the sea but the light is emitted continuously and usually of very low intensity and rarely if ever figures significantly in the bioluminescent light budget of the coastal zone. In both field studies this year capture effeciency was evaluated by fitting the MDDBPs with nets to capture organisms from the BP's exhaust. The numbers and kinds of these were compared with organisms caught in an immediately adjacent Shindler trap, which provides an excellent representation of organisms present. Organisms collected by both methods were sorted into motile and non or poorly motile categories. For Monterey, the MDDBPs and Shindler trap data were not significantly different, indicating that the MDDBP effectively samples the candidate population. The LEO-15 collections are being evaluated.

Another test of capture effeciency was conducted at Monterey in which an MDDBP was run on an ROV also equipped with a "splat screen" (Widder). The splat screen permits classification of many organisms by their characteristic luminescence when they are hit by the advancing screen. The diameter of the screen is so large that it seems likely that it samples impartially. This data comparison remans to be completed.

The two MDDBPs provided to the Naval Oceanographic Office were operated attached to a HIDEX on a typical survey cruise. They have just been returned and we are looking forward to receiving the data when it is available. During LEO-15 an additional small amount of comparative data was obtained by near simultaneous profiling of an MDDBP and a HIDEX. An understanding of how the MDDBPs perform in comparison to HIDEX is deemed critical since it is the criterion bioluminescence instrument for NAVO.

Lab tests were conducted with guidance from Dr. J. Yen regarding copepod escape dynamics. In addition, flow patterns around inlet and exhaust ports of the MDDBP were videotaped. Motion of neutrally bouyant particles visualized in laser-defined planes was analysed with motion analysis software. We have discussed this work with Dr. P. Lenz and D. Hartline, experts in copopod escape behavior. The tentative conclusion is that while many copepods respond quickly and precisely enough to dodge a well defined disturbance under laboratory conditions, such as in our experiments, in nature the turbulence field around an instrument in profiling mode is likely to be so chaotic that an escaping organism is probably will not have a directional frame of reference accurate enough to produce an accurately directed escape response.

IMPACT/APPLICATIONS

Investigation of marine bioluminescence is hindered by lack of availability of an instrument such as has been developed in this project. We hope that its characteristics will make it useful as a general oceanographic instrument and thus greatly increase the frequency with which bioluminescence measurements are made at sea in the course of general investigations in biological oceanography.

TRANSITIONS

It is anticipated that the MDDBP deployed in July 2000, on the LEO-15 optical node will continue indefinitely in use and be maintained by the UCSB/CalPoly Group. It was refurbished last winter and redeployed in June.

We anticipate placing MDDBPs on moorings already instrumented in the Santa Barbara Channel to study and track the progression of bioluminescent blooms in this region. Through collaboration with

other researchers at UCSB, we will have access to rain runoff data, surface current velocities, ocean color images from satellites, and other physical data. We hope to be able to provide MDDBPs eventually to existing and anticipated moorings between the San Diego and Monterey Bay (Case, Moline, Haddock, Latz)

PUBLICATIONS

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